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Evaluating telecom nets requires updated indicators

CHARLES BORSOS

THE STATE OF development of the telephone network and the spread of the telephone services in individual countries have usually been characterized by three indicators: the density of telephone sets; the percentage level of automation; and the proportion of main sets and extension telephone sets.

These indicators showed to what extent the telephone network was in accordance with the general level of the economy. The most significant of the three was the degree of density of telephone sets. Previously, at the low or the medium level of network development, these indicators could be used to perform economic calculations and to elaborate development projects. However they are not applicable anymore. The development of telephone networks is progressing in the Third World, where the production, structure and the composition of the families differ significantly from the American and European models.

Based on the following information, one must conclude that the use of new indicators is necessary.

An evaluation of indicators presently in use provides a basis to form new indicators.

Density

The density of telephone sets is the number of sets (main and extension) per 100 inhabitants of a country, city or region. The number of sets is an unweighted total of the main sets of public authorities, their main lines and private branch exchange (PBX) extensions, main and extension residential sets and public sets. (For the purpose of this article, the term sets of public authorities means all sets used for administrative, business and professional purposes.)

The word unweighted is important here because the density of telephone sets includes the residential extensions despite the fact that the extensions have no significant influence on the original calls. Their use only increases convenience and speeds up the reception of incoming calls. Due to this fact the residential extension sets should not be taken into consideration when counting residential sets. But the extension sets of the public authorities do contribute to the number of originated calls and, therefore, they should be taken into account.

The data shown in Table 1 indicate that it is expedient to treat the main and extension sets of the public authorities jointly. The proportion of the main and extension sets of the public authorities is independent of the country's economic development; instead, it depends on the administrative methods adopted.

The density of telephone sets does not reflect the economic structure of countries or their social conditions. Comparing the density of telephone sets in Switzerland and Sweden (Table 1) which are countries with similar economic levels, it can be seen that Switzerland has 31.6 public authority sets per 100 persons, and Sweden has 22.2 sets per 100 persons. Thus, Switzerland has 42.3% more public authority sets, per 100 persons than Sweden. This difference cannot be explained by underdevelopment, but is explained by the different economic structure of the two countries considered; that is, by the different needs of the dominant economic branches for telecommunications. Commerce and servicing branches need more telecommunications than, for example, agriculture if telecom-

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Table 1

Distribution of public authority and residential telephone sets

Jan. 1, 1978

	Density of telephone sets			Public authority sets			Residential sets		
	nationwide	public authority	resident	main sets	extension sets	extensions per main sets	main sets %	extensions sets %	extensions per main sets
Bulgaria	10.7	5.9	4.8	45	55	1.22	100	0	0
Canada	63.2	21.2	42.0	54	46	0.87	66	34	0.53
Czechoslovakia	19.0	12.6	6.4	29	71	2.47	100	0	0
East Germany	17.1	13.1	4.0	26	74	2.87	100	0	0
Greece	25.1	7.9	17.2	43	57	1.35	100	0	0
Hungary	10.3	7.2	3.1	25	75	3.06	100	0	0
South Africa	9.8	5.6	4.2	26	74	2.86	100	0	0
Spain	26.3	15.5	12.8	55	45	0.79	64	36	0.57
Sweden	71.7	22.2	49.5	21	79	3.87	93	7	0.08
Switzerland	65.9	31.6	34.3	23	77	3.35	100	0	0
England	41.5	16.9	24.6	39	61	1.57	84	16	0.19

munications costs needed to obtain one unit of money are compared.

When considering the density of telephone sets, the density of main residential sets does not indicate the degree to which the demands of the population are satisfied because satisfaction depends essentially on the number of households per 100 inhabitants and on the number of households served by each set. If, for example, the average number of inhabitants per residence is 2.5 in a country, then the saturation value for residences is 40 per 100 inhabitants as a first approximation. If the average number of family members is five persons, then the saturation is achieved at a density of 20 per 100 inhabitants.

Summing up, it can be concluded that the density of telephone sets as an indicator is easy to calculate, but this measure does not show whether the actual number of the sets is sufficient under the circumstances. This measure is not suitable for comparison and represents a trap that may mislead technical and economic planners.

Percentage level of automation

The measure of the relative level of automation indicates the percentage of the main telephone sets served by automatic exchange within a country or its territorial units. This indicator is at least as misleading as the indicator of the density of telephone sets.

Based on this proportional measure, higher value is placed on a totally unserved rural area than on a manually activated system which provides limited services.

Assuming, as an extreme case, that in an underdeveloped country where telecommunications service is not yet highly organized, the captial city has a very modern automatic network. In this case the level of automation will be 100%. One may be willing to qualify this network as more advanced than a network in towns with well organized, manually-activated service where 25% of the telephone sets are located. In this latter country, the degree of automation will be only 75%

However, the manually-activated service must be qualified as superior to one without any service, or with very little service. In addition, the needs of a low level agriculture or livestock farming area may be well-served with a manually-activated network. Again, in the case of a high level agricultural area, a suitable telecommunications network is more necessary for a efficient operation than it is in an industrial working area with close plant because cultivation is strongly influenced by the unpredictable weather, and the amount of precipitation, and because cultivation encompasses a large territory with the cooperation of a number of related industries.

The basic fault of this automation indicator is that it provides information only about the composition of the existing equipment, but does not give guidance as to what percentage of the population will be able to reach the more advanced service.

Main and extension sets

The proportional distribution of the number of the various types of main telephone stations, substations, PABXs (private automatic branch exchanges) as well as the extension sets of public authorities and residences may be used to measure the state of development of a telephone network. Considering that the total number of main telephone stations and substations is composed of essentially different types of sets, it becomes clear that this percentile measure in not useful in practice.

The load carrying capacity of the network not decline if extension sets are installed in residences. Nor will the main lines to PABXs be less overloaded if the number of residential main lines increases. From the point of view of the load capacity, the proportion of the main and extension lines connected to PABX may only be considered as determinant for main and extension sets. The usual proportion is 10% and 90% respectively for main and extension sets. The proportion of the extension sets in developed networks such as Sweden's increases continuously. This phenomena is shown in Table 2. The same tendency may be observed in Spain.

On the other hand, Table 3 shows that this tendency turns in the opposite direction in West German networks.

The data in Tables 2 and 3 show that the proportion of main and extension sets and the change in time of this proportion does not refer to the quality of the provision. This indicator is, therefore, useless.

A new method is needed to evaluate the level of development of the telephone network.

Comparison of the networks of various countries and evaluation of the domestic network of any country requires a method which starts with the analysis of the degree of satisfaction of the telecommunications demands developed on the basis of the industrial production and social structure of the country or region

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Table 2

Proportion of extension sets in Sweden

Year	Density of sets	Percentage main sets	Extension sets
1960	36.81	78.5	21.3
1965	45.96	76.9	23.1
1975	55.64	74.9	25.1
1978	74.40	69.3	30.7

Table 3

Proportion of extension sets in West Germany

Year	Density of sets	Percentage main sets	Extension sets
1960	10.71	54.7	45.3
1965	14.84	56.7	43.3
1970	22.43	63.6	36.4
1978	40.30	71.2	28.8

Continued from page 38

being considered. The level of the telephone networks of countries cannot be evaluated, as in the case of the density telephone sets, in relation to an incomprehensible number varying from 100 sets per 100 inhabitants to 200 per 100 inhabitants according to technical sources; nor in relation to the actual density values observed in the most developed countries. The ratio number of sets connected to the automatic exchange does not refer to the degree of provision within the population, but to the method of switching. Although it is easy to calculate, it is a meaningless number.

Instead of the indicators used up until now, it seems necessary to develop a new method of evaluation which will provide an accurate analysis of the degree of telephone provision. It is possible to develop indicators which are devoid of the defects of the presently used indicators and makes networks comparable on the basis of demand and degree of provision. The proposed first indicator will tentatively be called the *degree of standard saturation* and should be determined for every country. The second indicator will tentatively be called the *degree of accessibility to automation* and would indicate the proportion of the population served by automatic equipment. The indicator of the proportion of main and extension telephone sets should be omitted. The method of computation and application of these two indicators is discussed below.

Degree of standard saturation

Telephone sets connected to the network may be grouped into three categories depending on their role in the production and society, on the load carried by them and on their investment costs: main and extension sets of public authorities, residential sets and public sets.

Main and extension sets of public authorities are considered as prerequisites of efficient production and administration. Therefore, their number should be determined not by the actual level of production, but by the desired level of production.

At a low density, the majority of sets must belong to the public authorities, and these and residential sets approximate the density value of 20 sets per 100 inhabitants.

The number of public authority sets depends on the production structure, the contribution of the various economic branches to the Gross National Product (GNP) and the administrative methods. For public authority sets, the degree of saturation may be computed from the total value of production of all economic branches.

Table 4 shows telecommunication cost ratios which are characteristic to production and economic branches, according to Linda Lee Bowler in her paper "Telecommunication Market Demand and Investment Requirements." Further investigations are needed and such analysis should be extended with data related to the telecommunication demands of the state administration.

The value of the standard saturation related to sets of public authorities is not an absolute value, but a measure that should be determined for each country separately. This measure does not depend on the number of employes in the various economic branches but on their output. In central Europe, in the 1930s the number of agricultural workers was about three times that of today and the value of farm-produce was about one-half the present value. In the 1930s the related telecommunication demands were well satisfied by a few manually-serviced sets. Presently, large-scale farming closely related to industries requires automated service, and VHF (very high frequency) mobile sets, apart from fixed sets.

The density values of public authority sets are higher in countries which are dominated by commerce and tourism than it is in countries which are dominated by agriculture and mining. This generalization takes into consideration the demands of state administrations. It also takes into account the VHF radio telephone sets which have access to the public networks.

Table 4

Telecommunication cost ratio for various branches of economy/production

Branches of economy/production	Cost ratio
Agriculture & forestry	0.0023
Mining & quarrying	0.0010
Construction	0.0034
Manufacturing	0.0040
Transport & communication	0.0104
Energy	0.0027
Wholesale & retail trade	0.0105
Finance insurance real estate	0.0087
Services	0.0147
State enterprises	0.0031

Residential sets

The degree of saturation of residential sets should be determined on the basis of the number of persons living in each household. In addition, it should be considered that some residences require two sets. There also may be a need for sets in some summer residences and mobile sets in some private cars. Saturation may be between 110 and 125 sets per 100 residences. This number does not include extension sets within residences.

The number of persons living in the same household varies between 2.5 and 4.2 in Europe. Lower figures are found in Sweden, Switzerland and Hungary. The maximum is found in Portugal. In Canada there are 3.3 persons per household, and in Australia 3.1 persons form a household. In South America, Asia and Africa, the number of persons living in a household is 6 or more.

Considering this data, the saturation value of 117 sets per 100 residences, which may be taken as average, means a density of 46.8 per 100 inhabitants in areas with 2.5 persons per household. If the number of persons per household is 6 then full provision is at a density of 19.5 per 100 main sets. These two extreme values show that a measure related to the population figure is less suitable to evaluate the degree of provision than a measure related to the number of residences or households.

Public sets

The standard density of public sets may be assumed as 1 set per 100 in-

habitants. Here the population using public domain is to be considered and provisions should be made that within inhabited areas so that anyone can find a free public set within a range of about 100 meters. Depending on the intensity of the traffic on the streets this requirement can be fulfilled by installing one to eight public sets per 2.47 acres. From this number, some sets may be installed on trains and long range buses as radio telephone sets.

Accessibility to automation

It has been shown that misleading conclusions may be drawn from measuring the percentage level of automation. Accessibility to automation, as an indicator provides the proportion of the population of a country that has access to public authority, residential or public telephone sets served by automatic exchange.

In Hungary, for example, the traditionally understood degree of automation is 82.2% despite the fact that only 48% of the population of the country can use automatic services. The value of 82.2% does not describe the real situation and leads to an incorrect conclusion.

The new indicators proposed are more appropriate to describe the level of the network of a country than the measure of density of telephone sets and percentage level of automation were.

The advantage of the presently used indicators is that they can be computed easily from population data and from the global data on telephone networks.

More data and economic and technical forecasting are needed for the proposed new indicators. Also, these proposed indicators do not present basic statistical data but rather, a numerical value that may be used with advantages and reliability in the economical and technical planning.

A difficult task, however, is forecasting the GNP for a given country. The effect of a 50% error in overestimation will result in a acceptable difference for long-term planning. For example, if in a certain country $4000 per capita GNP is actually achieved but, because of exaggerated or optimistic estimation, $6000 per capita GNP is used in the calculation, the density of the public authority sets will be 23 per 100 instead of 19 per 100, which means an excess of 2.0 per 100 in the number of main sets. If the proportion of main and extension sets is 50% to 50%, then the same applies for the extension sets.

If the density for the planned number of households and public sets in the country is raised from the actual value of 55 per 100 to 59 per 100, then the measure of the standard density will include an error of only 7.2% and the value of the density of main sets will have an error of only 4.4%. The error rate of 20% that is still tolerable in long-term planning cannot be reached practically. With the proposed new indicators, the degree of error will be significantly less than when computed with the presently used indicator of density sets, which may include an error up to 50%.

The accessibility of automatic service can be computed from population data and from the number of inhabitants in cities and villages of a given country served by automatic exchanges.

The use of these proposed indicators is possible, reliable and advantageous for those involved in economic and technical planning and forecasting. □

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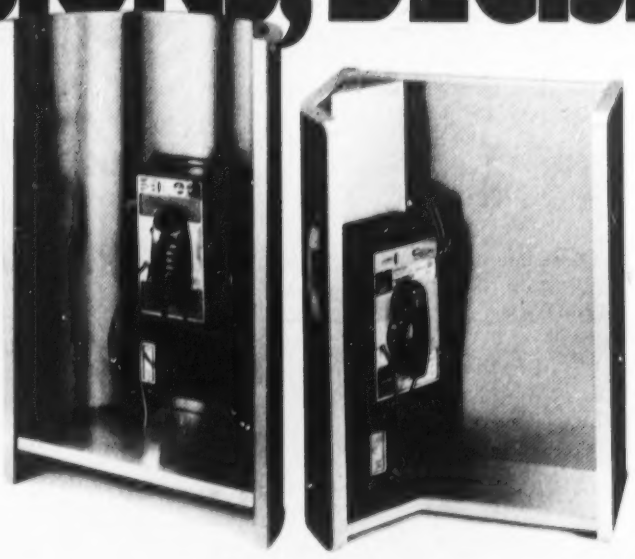

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